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Applicant: Van Eendenburg et al.

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Sir:

Pursuant to rule 55(b) of the Rules of Practice in Patent Cases, Applicant(s) is/are submitting herewith a certified copy of the European Application No. 99204358.8 filed December 16, 1999, upon which the claim for priority under 35 U.S.C. § 119 was made in the United States.

It is respectfully requested that the priority document be made part of the file history.

Respectfully submitted,

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Bescheinigung | Certificate | Attestation

Die angehefteten Unterlagen stimmen mit der ursprünglich eingereichten Fassung der auf dem nächsten Blatt bezeichneten europäischen Patentanmeldung überein.

The attached documents are exact copies of the European patent application described on the following page, as originally filed.

Les documents fixés à cette attestation sont conformes à la version initialement déposée de la demande de brevet européen spécifiée à la page suivante.

Patentanmeldung Nr. | Patent application No. | Demande de brevet n°

99204358.8

Der Präsident des Europäischen Patentamts;
Im Auftrag

For the President of the European Patent Office

Le Président de l'Office européen des brevets
p.o.

I.L.C. HATTEN-HECKMAN

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Process and equipment for the manufacture of edible spreads

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PROCESS AND EQUIPMENT FOR THE MANUFACTURE OF EDIBLE SPREADS

The present invention deals with a process for the manufacture of margarine and other fat continuous emulsion spreads and with equipment for carrying out such process.

BACKGROUND OF THE INVENTION

A typical manufacturing process for edible fat continuous emulsion spreads such as margarine, starts with an aqueous phase and a fat phase in which phases the spread ingredients have been dissolved.
Common processing lines for spread manufacture comprise devices for mixing, emulsifying, cooling, particularly scraped surface heat exchangers and devices for working and crystallizing the cooled emulsion, particularly pin stirrers. Resting tubes are inserted in the line for increasing residence time and for allowing the cooled emulsion to crystallize and plasticize under quiescent conditions.

The process results in a fat phase with a network of fat crystals which stabilizes the emulsion. The design of a spread manufacturing process aims at - *inter alia* - an optimum average size and size distribution of the emulsion's aqueous phase droplets and a proper product hardness at the moment of packing.

Scraped surface heat exchangers are cooling devices provided with blades mounted on a central axis. During processing the emulsion ingredients are mixed, while the blades scrape the solidified fat from the inner surface of the liquid ammonia cooled wall. For cooling liquid material such scraped surface heat exchangers are very effective, but effectivity drops when the viscosity of the processed material increases, e.g. when crystallisation of the fat phase proceeds.

Pin stirrers act as a stirring and working device. Their effect is based on shear caused by protruding pins mounted on a central axis which rotates with a speed which may be adapted to the desired extent of working. With a pin stirrer the crystallisation of the fat phase can be controlled.

A margarine manufacturing line according to the present state of the art contains scraped surface heat exchangers as well as pin stirrers in a number and in an order which is dictated by the properties wanted for the final product.

Alternative cooling devices are tubular heat exchangers and cooling coils that use cold or ice water. For emulsifying a homogenizer, a colloid mill or a pressure valve may be employed, instead of or besides pin stirrers.

Detailed information for margarine manufacturing technology can be found in the textbooks K.A. Alexandersen, "Margarine Processing Plants and Equipment" and Bailey's Industrial Fat and Oil Products, New York 1996, Wiley & Sons Inc., Vol.IV, Chapter 10.

A few prior art references mention still other types of margarine manufacturing equipment. According to Japanese patent JP 61/289838 margarine can be prepared with a double shafted extruder which is provided with two cooperating screws, a so-called twin screw. Such equipment is chosen for food processing when thorough mixing of viscous matter is wanted. All functions for margarine processing: heating, blending, emulsification, cooling, kneading and crystallization are said to be performed in this single device. Although the reference hardly contains product qualifications, it is clear that the characteristic purposely high shear produced in a twin-screw is disturbing the delicate network of fat crystals and consequently decreases the hardness of the product.

The art of spread processing has a great impact on taste, mouthfeel, consistency and stability of the final product. Although great progress has been made in the long history of margarine manufacture, still many improvements are desired of the product quality, of the consistency as well as of the organoleptic properties of margarine and other fat-continuous emulsion spreads.

A typical manufacturing process of margarine, and of other fat continuous emulsion spreads, may proceed as follows: in separate storage vessels the fat phase and the aqueous phase are prepared by mixing the ingredients. Metering pumps transfer the two mixtures in the correct ratio to a pre-mix vessel where the aqueous and the fat phases are combined to a crude emulsion. This emulsion is pumped into the manufacturing line and subjected to various treatments comprising emulsification, cooling, working and crystallisation resulting into a more or less liquid intermediate emulsion which subsequently is crystallized and finally yields the desired spread. The consecutive treatments change the consistency of the product, particularly at the end of the line where the intermediate emulsion becomes increasingly more plastic and viscous by crystallisation of the fat phase.

With present manufacturing processes the transformation of the more or less liquid intermediate emulsion into a spread which has the hardness/plasticity desired for packing, is not yet accomplished to full satisfaction. This final process step is carried out by a cooling device at the end of the line, shortly before packing. Presently, a scraped surface heat exchanger (SSHE) is used for that task. This device has serious drawbacks, however. Its cooling functionality increasingly fails when the crystallizing spread becomes more viscous. The SSHE cooler needs a pump for conveying the increasingly more viscous spread to the end of the line. However, both the pump and the SSHE generate shear energy, which has an undesired influence on the spread temperature and the spread's consistency.

The consequence is that the cooling of the spread in the cooling device may not proceed so far as is necessary for obtaining the desired hardness at the packing machine. Another consequence is that particularly wrapper margarines become such solid with cooling, that they can not be processed and delivered to the packing machine at temperatures of 5°C and below. This may afford a conflict with the retail business which in future will demand packing at those low temperatures.

The present invention addresses the above problem and has provided a solution.

SUMMARY OF THE INVENTION

The invention consists of a processing line that is suited for the manufacture of W/O emulsion spreads and that consists of at least two connected devices through which consecutively the ingredients for preparing a spread are conducted for processing, characterised in that the line comprises a single-screw cooler which is provided with a screw mounted in a barrel, where the distance of the flight of the screw to the inner wall of the barrel is 0.1 - 2 mm.

The invention also provides a process for the manufacture of a fat continuous emulsion spread from usual ingredients, which process comprises a first treatment and a subsequent second treatment, where the first treatment consists of a usual series of consecutive steps comprising subjecting the chosen emulsion ingredients to one or more mixing, emulsifying, cooling, crystallizing and working treatments in any order and number that is suited for obtaining an intermediate liquid fat continuous emulsion, and where the second treatment comprises cooling the intermediate emulsion in such way that it crystallizes and changes into a plastic emulsion spread,
which process is characterised in that the crystallisation of the intermediate emulsion is performed by conducting it

through a single-screw cooler according to claim 1 or 2 and, optionally, through a subsequent resting tube.

SHORT DESCRIPTION OF THE FIGURES

Figures 1 and 2 show schematical views of spread manufacturing lines.

Figure 1 shows a traditional spread manufacturing line containing storage vessels P for prepared aqueous phase and fat phase, only scraped surface heat exchangers (A) for cooling, a pin stirrer (C), a resting tube (B), a packing machine (PM), a rework line (RM) and pumps (triangles).

Figure 2 shows a manufacturing line according to the invention. That line is very similar to the line of figure 1, but a single-screw cooler (S) has substituted the scraped surface heat exchangers at the end of the line. The meaning of the other signs is the same as in figure 1.

DETAILS OF THE INVENTION

A single-screw cooler is a device which consists of a screw in the form of a helix mounted on a central axis which can revolve in a barrel. Since long single-screws are employed for transporting fluid, even highly plastic matter which may be food or non-food.
The original, still simple single-screws are sometimes denoted as Archimedes screws and are suited for transport only.

The single-screw becomes a single-screw cooler when it is provided with cooling means, in the form of a double wall through which a cooling liquid, e.g. ice water, cooled brine, boiling ammonia or freon can be conducted.

Single-screw coolers are known devices which have been appreciated for effectively transporting and cooling fluid materials, including food compositions such as ice-cream. In the manufacture of non-fluid fat-contuinuous emulsion spreads, however, their lack of useful functionality may have prohibited practical use.
Until the present invention, the single-screw cooler was not employed as cooling device for the crystallisation of viscous spread emulsions.
It should be noted that a spread has to comply with high standards with respect to appearance and texture, which properties are strongly influenced by the treatment with the cooling device at the end of the manufacturing line.

For a proper performance it is essential that the single-screw cooler employed in the present invention is able to cool effectively a highly viscous emulsion spread, while conveying it through the device. Such performance can not be attained with common single-screw coolers.

It is the merit of the present invention to have acknowledged the essential feature which turns the common single-screw cooler into a most useful part of a spread manufacturing line. This feature is the unusual small clearance, the small distance between the flight of the screw and the inner wall of the barrel. A tight fitting has appeared to be essential for proper cooling of the viscous spread emulsion.

In the single-screw cooler as applied in the present invention said distance is only 0.1 - 2 mm, preferably 0.1 - 1 mm, more preferably, 0.1 - 0.5 mm.

Generally, the clearance of a single-screw cooler is already small, but never below 2 mm. In WO 98/09536, for example, a single-screw cooler is described as part of an ice-cream device. It has a clearance of a tenth of an inch, which is 2.54 mm.

The single-screw cooler to be used in the present invention possesses the critical clearance of 0.1 - 2 mm. Such narrow clearance has a substantial bearing on effectiveness of the cooling of fat continuous spread emulsions.

The narrow clearance distinguishes the present device from different types of single-screw coolers which are not suited for use with the present invention.

When operating, a single-screw cooler generates so little shear energy that the spread does not suffer from warming up or getting overworked. This is in contrast to multiple screw coolers, such as the twin-screw coolers mentioned above, which are employed for effective mixing because they generate much shear. Inevitably, the shear of such devices would adversely affect the vulnerable crystalline structure of the spread. Moreover, the construction of multiple-screws does not allow the superior cooling function of the single-screw coolers of the present invention.

In another aspect a single-screw is superior over twin screws because the construction simplicity results into reliability and economy.

Often the performance of the single-screw cooler can be enhanced by connecting it to a subsequent resting tube. When fat crystallisation is not yet complete at the exit of the single-screw cooler, the cooled spread, by proceeding through the resting tube, is allowed extra residence time for completing its crystallisation process.

In the present invention the single-screw cooler is both a very effective cooling device and an effective, low shear conveyor of viscous materials, so that line pressure can remain low.
Therefore the single-screw cooler is able to convey by itself the highly plastic spread in the second part of the process, even when vicosity has increased more than usual after a line stand-still.

By employing a single-screw cooler the spread can be subjected to the deep and prolonged cooling needed for realizing the desired packaging hardness in the line without the need of post-cooling in a warehouse. It is possible to cool the spread to temperatures of 5°C and lower, which can not be realized with prior art spread manufacturing equipment.

Preferably, the spread is cooled so far that a Stevens value for hardness is attained which is at least 30 g when the spread is meant for packaging in a tub or at least 160 g when it is meant for packaging in a wrapper. Stevens values for hardness are established according to the protocol described in the experimental part of this specification.

Although the single-screw cooler is particularly suited for processing spreads which are particularly sensitive for overworking, such as margarine, containing 80 wt.% of fat, it is suited as well for the manufacture of spreads having lower fat contents, even as low as 35 wt.%. Generally, the softer consistency of such low-fat spreads need deeper cooling for preventing packing problems. With the present invention the spread may be easily cooled to the temperature where the desired packing hardness is obtained.

Preferably the process of the invention is carried out in such way that the intermediate emulsion has sufficient stability that it will not suffer from a short interruption of the flow by a line stand-still. Stability means that no visible phase separation occurs when the emulsion is left to quiescent conditions up to half an hour, preferably up to one hour. This is effected by cooling the intermediate emulsion only slightly, so that in the fat phase just enough fat crystals are produced to surround and protect the aqueous phase droplets.

The steps of the first treatment of the process are according to traditional common technology and need no further explanation or specification. They are chosen such that the intermediate emulsion has a dispersed aqueous phase with a satisfactory droplet size distribution and average droplet size. Satisfactory means that in the final cooling part of the process no further treatments are necessary for improving the dispersed aqueous phase. 2-20 μm is a satisfactory average size of the aqueous phase droplets in the intermediate emulsion product which is equal to the desired size for the end product.

The devices for preparing the intermediate emulsion are chosen from those known from traditional, common spread manufacturing technology (see Alexandersen and Bailey's, *supra*), comprising, for example, scraped surface heat exchangers, cooling coils, tubular heat exchangers, twin screw, pin stirrers, homogenizers, colloid mills and pressure valves. They are employed according to current

spread manufacturing technology, for example in an A-A-A-C sequence where A denotes a scraped surface heat exchanger and C denotes a pin stirrer. The processing proceeds at such temperatures that the resulting intermediate emulsion is liquid, although a small part of the fat phase may be present in crystallized form.
Any scraped surface heat exchangers and pin stirrers in the first section of the line as illustrated by figure 2 may be replaced by devices having comparable functionality, provided a ready and liquid emulsion results as intermediate product.

Also the ingredients for the liquid W/O-emulsion are not different from the common ones for spread manufacture. The aqueous phase which is 15-90 wt.% of the emulsion, may comprise, besides water, proteins such as whey powder and skimmed milk powder, structuring agents, thickening agents and gelling agents such as gelatine, an edible acid, such as lactic acid, a preservative such as potassium sorbate.
The fat phase which is 10-85 wt.% of the emulsion, comprises a suitable fat blend, such as sunflower oil containing a structuring fat such as an interesterified mixture of palm stearin and palm kernel stearin. Suitable fat phase ingredients are further emulsifiers like lecithin and monoglycerides, flavour, colour such as beta-carotene. See for general information about ingredients and processing the already mentioned textbooks and also The Chemistry and Technology of Edible Oils and Fats and their High Fat Products (G. Hoffmann; Academic Press London,1989, page 319 ff).

For the second treatment of the process of the invention which aims at crystallisation of the intermediate emulsion a single screw cooler is used. Provided the clearance of its screw and barrel is 0.1 - 2 mm, it will provide exemplary cooling. It can easily cope with the resulting viscosity increase and will gently and effectively convey the plastic spread towards the line's exit, without seriously disturbing the crystals lattice of the spread. Because pumps are absent in the crystallisation section of the manufacturing line, little heat energy is dissipated in the product flow.

Use of a single-screw cooler also has beneficial safety and environmental aspects. Compared with the current manufacturing processes the product stays much longer in the cooler device. Then harmless brine or ice water is a proper cooling medium. It is not necessarily to use the dangerous and expensive liquid ammonia employed in current scraped surface heat exchangers, which very low temperature is necessary for quick cooling.

An additional benefit of the invention is that spreads produced with a single-screw cooler show better product properties with respect to appearance, texture and taste. Particularly appreciated properties like yellow colour, gloss, good spreading and (mouth) melting properties, less grainy and lumpy mouthfeel, creaminess, flavour intensity, less intense off-flavour notes and a longer lingering taste have improved.

The benefits and advantages of spread manufacture using a single-screw cooler can be summarized as follows:

- Effective cooling of highly viscous materials,
- Effective conveying of viscous spread material,
- Stable production process,

- Relatively cheap, reliable equipment,
- Control of line pressure at an acceptable level,
- Product packing at a temperature as low as 2°C,
- Better hardness of end product,
- Improved consistency and better organoleptic properties of product,
- Harmless, environmental friendly cooling medium.

PROTOCOL FOR MEASUREMENT OF STEVENS VALUES

The spread is equilibrated at the measuring temperature for 24 hours. The "Stevens" hardness S(t) at temperature t, expressed in grams, is measured in a Stevens-LFRA Texture Analyser (ex Stevens Advanced Weighing Systems, Dunmore, U.K.). Measurement specification: 4.4 mm diameter cylinder; load range 1000 g; device operated "normal" and set at 10 mm penetration depth and 2.0 mm/s penetration rate.

ORGANOLEPTIC ASSESSMENT

Three processes resulted in three products which have been submitted to an organoleptical assessment.

Process A uses traditional spread manufacturing technology and traditional ingredients which are used for the preparation of a spread which is presently on the market, except that for the final cooling step a single-screw cooler was employed.

Process B was identical to process A except that it was applied with a throughput which was 50% higher than the throughput of process A.

Process C was identical to process A except that it was applied without a single-screw cooler, using a scraped surface heat exchanger for final crystallisation.

The three resulting products, product A, product B and product C have been subjected to an organoleptic panel for assessing many product attributes relating to taste and product structure.

Table I shows only the attributes for which significant differences have been found. Relative scores have been assigned, where rating 3 is for the product with the highest score and rating 1 is is for the product with the lowest score. For some attributes products score equal.

Because all attributes have been expressed with a positive desired quality the ratings can be added together. The added figures show a clear improvement of product A and particularly of product B over the traditional product C. The higher throughput results in, generally, better product properties. The improvements of products A and B in comparison with C must be ascribed to the use of the single screw cooler, since ingredients do not differ.

AHS

TABLE I

POSITIVE ATTRIBUTES	**Product A**	**Product B**	**Product C**
Appearance			
Yellow	1	3	2
Glossy	2	1	3
Texture			
Smooth spreading	2	3	1
Less grainy mouthfeel	2	3	1
Quick melting	2	3	1
Less lumpy mouthfeel	3	2	1
Taste			
Creamy	2	3	1
Intensity	2	3	1
Less cooked milk	2	1	3
Less cardboard	2	3	1
Less old fat	1	2	3
Salty	2	3	2
Lingering taste	2	3	2
Accumulated relative scores	25	33	22

16. 12. 1999

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CLAIMS

1. Processing line that is suited for the manufacture of W/O emulsion spreads and that consists of at least two connected devices through which consecutively the ingredients for preparing a spread are conducted for processing, characterised in that the line comprises a single-screw cooler that is provided with a screw mounted in a barrel, where the distance of the flight of the screw to the inner wall of the barrel is 0.1 - 2 mm.

2. Processing line according to claim 1, characterized in that the distance of the flight of the screw to the inner wall of the barrel is 0.1 - 1 mm, preferably, 0.1 - 0.5 mm.

3. Processing line according to claim 1, characterized in that it comprises a first section with one or more devices for cooling, emulsifying, crystallisation and working the spread ingredients which section is suited for the preparation of a fat-continuous emulsion and a second section downstream from the first section which comprises the single-screw cooler.

4. Processing line according to claim 3, characterized in that the devices in the first section have been chosen from the group consisting of scraped surface heat exchangers, cooling coils, tubular heat exchangers, twin screws, pin stirrers, homogenizers, colloid mills and pressure valves.

5. A process for the manufacture of a fat continuous emulsion spread from usual ingredients, which process comprises a first treatment and a subsequent second treatment, where the first treatment consists of a usual series of consecutive steps comprising subjecting the chosen emulsion ingredients to one or more mixing, emulsifying, cooling, crystallizing and working treatments in any order and number that is suited for obtaining an intermediate liquid fat continuous emulsion, and where the second treatment comprises cooling the intermediate emulsion in such way that it crystallizes and changes into a plastic emulsion spread,
which process is characterised in that the crystallisation of the intermediate emulsion is performed by conducting it through a single-screw cooler according to claim 1 or 2 and, optionally, through a subsequent resting tube.

6. A process according to claim 5, characterized in that the intermediate emulsion is stable, where stable is to be understood as that no visible phase separation occurs when the emulsion is left to quiescent conditions up to half an hour, preferably up to one hour.

7. A process according to any one of claims 5 - 6, characterized in that the intermediate emulsion is cooled until a Stevens hardness value is attained which is at least 30 g in case the spread is meant for packing in a tub or at least 160 g when it is meant for packing in a wrapper.

A B S T R A C T

A process for the manufacture of an edible plastic emulsion spread using common spread ingredients and employing a traditional processing line, but using a single-screw cooler for cooling and crystallizing the intermediate liquid W/O-emulsion.

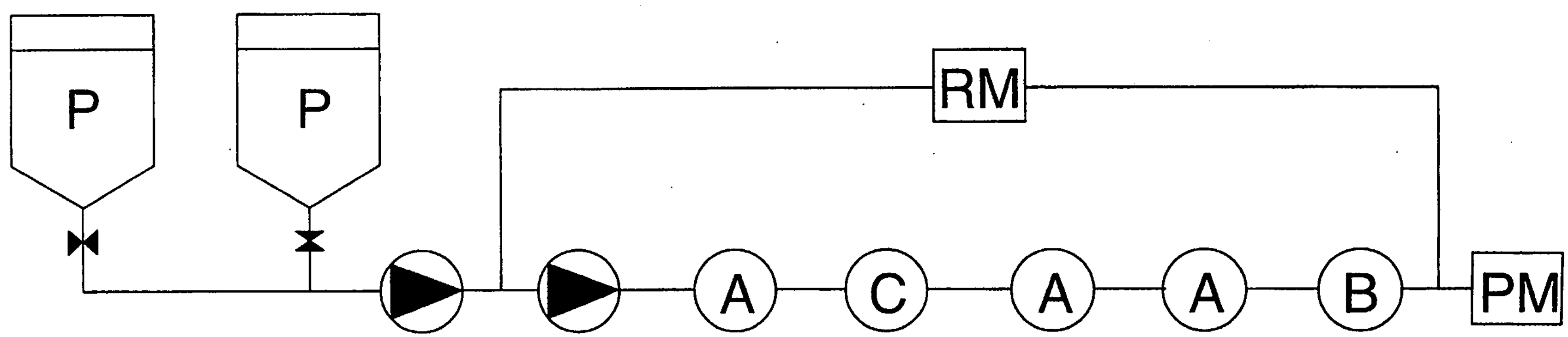

Figure 1

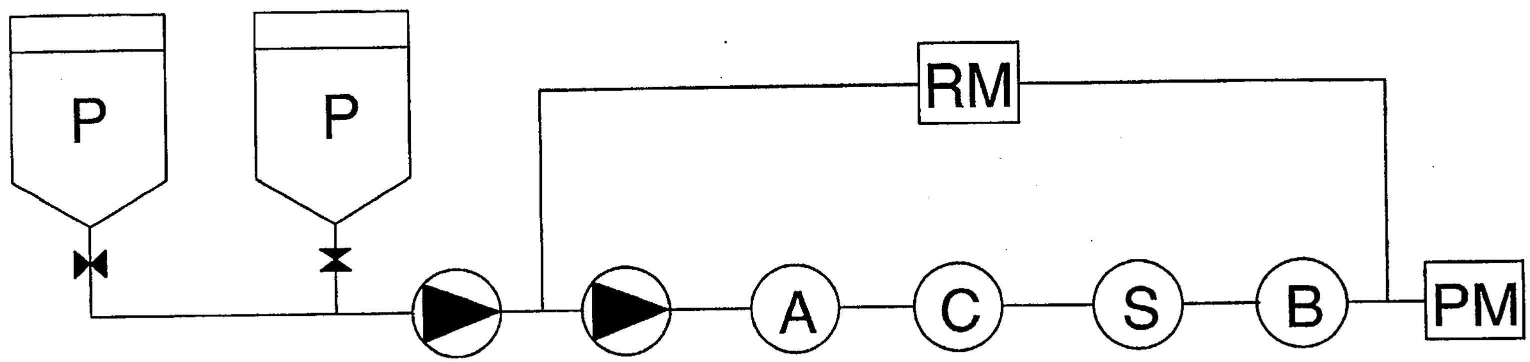

Figure 2